

Movements and Habitat Use of Dwarf and Pygmy Sperm Whales using Remotely-deployed LIMPET Satellite Tags

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LONG-TERM GOALS

Dwarf (*Kogia sima*) and pygmy (*K. breviceps*) sperm whales are among the least known species of odontocetes, despite their distribution in oceanic waters world-wide. There is some evidence that both species may be at least occasionally impacted by Navy sonar activity (Hohn et al. 2006; Weilgart 2007). The long-term goals of this research are to reduce uncertainty regarding movements and habitat use of these species in Hawaiian waters, an area where these species are exposed to Navy activities.

OBJECTIVES

The objectives of this research are to assess site fidelity, movements, and habitat use of dwarf and pygmy sperm whales in Hawai‘i over periods of weeks to months, using photo-identification and remote deployment of LIMPET satellite tags. Knowledge of site fidelity and movements among islands will allow for assessment of the likelihood of repeat exposure to anthropogenic activities, as well as determination of whether individuals are part of smaller island-associated populations or open-ocean populations. The results will also help in identifying preferred habitats where overlap with anthropogenic activities is most likely to exist.

APPROACH

Field operations

Dwarf and pygmy sperm whales have a reputation for being difficult to approach (Willis and Baird 1998), and there has been limited work with free-ranging individuals of either species in the wild anywhere in the world. Since 2003, as part of a multi-species study of odontocetes in Hawai‘i (Baird et al. 2013), we have been working with dwarf and pygmy sperm whales using small vessels, involving approaching groups for individual photo-identification (Mahaffy et al. 2009). As part of this work we have been able to identify certain behavioral patterns of dwarf sperm whales that facilitate relatively close approaches to the animals without obviously disturbing them. With this experience, during field projects in 2013, 2014, 2015, and early 2016, we will undertake small-boat based field projects in Hawaiian waters, and approach groups of either species with the intent to attempt tagging using LIMPET satellite tags (see e.g., Schorr et al. 2009; Baird et al. 2011a). When survey conditions are particularly conducive to finding these species (e.g., Beaufort 0 and 1), field efforts will be

concentrated in specific depth ranges where previous surveys have indicated relatively high density of dwarf sperm whales (Baird et al. 2013). To maximize the chances of success at tagging these species, the research vessel will primarily be operated by the PI, who has extensive experience driving small vessels around this species, and the tagger will be Daniel Webster, who, as of September 2015, has deployed 202 LIMPET tags on 13 different species of odontocetes (including 50 tags on six different species of similar-sized odontocetes).

Tags used will be Wildlife Computer Spot-5 location-only or Mk10A location/dive tags in LIMPET configuration. Location-only tags will be programmed to transmit ~12 hours per day with transmission hours corresponding to those hours with the greatest satellite coverage, but with hours spread out over the day to allow for obtaining multiple locations each day. Locations would be obtained both during the day and at night, to allow for comparisons of day- and night-time habitat use and movements (cf. Scott et al. 2001). Location-dive tags will be programmed to transmit ~18 hours per day, to maximize the likelihood of obtaining complete dive records as well as location information.

When encountered, dwarf and pygmy sperm whales will be approached slowly, with efforts made to remain with the group for as long as possible while minimizing the likelihood of disturbing individuals. From previous experience with these species, and other difficult-to-approach species such as beaked whales, we have learned that groups can be followed for extended periods by obtaining GPS positions on the location where whales dive, remaining close (<100 m) to those locations while the whales are down, and repeating this in an iterative fashion over a series of dives to obtain the general direction, speed of travel, and spatial spread of a group. After determining this during a series of surfacing/dive cycles, it is possible to predict approximately where individuals will surface after long dives, allowing for closer approaches and longer encounters than would otherwise be possible. It is using this iterative process that we expect to be able to occasionally deploy LIMPET satellite tags. If it is possible to tag more than one individual within a group, a second tag would be deployed, to allow for assessment of group dynamics, and, if individuals separate, to obtain information on more than one group. During this process we will also be photographing all individuals present.

If tagged individuals remain within our study area during ongoing field projects we will attempt to use Argos locations and uplinks received in the field to re-locate the tagged individual, to assess tag attachment and also to obtain photos of companion individuals for re-sighting analyses.

Data processing and analyses

Argos location data obtained would be processed to eliminate unrealistic locations using the Douglas Argos-filter. Filtered locations would be processed with ArcGIS to obtain bathymetric data (depth, slope, distance from shore) for each location. If more than one tag is deployed with a temporal overlap in tag data, distances between locations received on the same satellite overpasses will be calculated with an R program, to determine whether individuals are acting independently or in concert. Data would be analyzed to assess habitat use (preferred depth, slope, distance from shore), movements in relation to the island slope, day/night differences in habitat/movements, and, if individuals move offshore, movements in relation to eddy fields (e.g., Woodworth et al. 2011).

Photos obtained of tagged and companion individuals will be added to a long-term photo-identification catalog (Baird 2005; Mahaffy et al. 2009). Photos will be used to assess sighting history and sex (for those previously documented with/without calves present), to aid in interpretation of movement data. Information on the depth of the group, combined with the sighting history and association patterns of individuals within the group, would also be used to assess whether the individual was part of the

island-associated population or an open-ocean population (cf. Baird et al. 2011b). Association analyses will be undertaken in SOCPROG and network analyses illustrated using Netdraw.

WORK COMPLETED

Field operations were undertaken off Hawai‘i Island in five periods between October 2013 and May/June 2015. Dwarf sperm whales were encountered on nine occasions during these operations. All encounters were in depths <1000 m (median = 650 m, range 425-849 m). Group sizes ranged from 1-6 (median = 2). Encounters ranged in duration from 1 min to 1 h 33 min. Eight of the nine encounters were terminated when the group was lost. While no satellite tags were deployed, we were able to photo-identify individuals in eight encounters, with 19 identifications obtained, representing 18 individuals (one was seen in both 2013 and 2014). Of the 18 individuals, 12 were categorized as adults. Of these, three were considered slightly distinctive, five were considered distinctive, and four were considered very distinctive. Excluding the three slightly distinctive individuals, as the probability of re-sighting slightly distinctive individuals is low, five of the nine distinctive or very distinctive individuals had been previously documented off the island. In addition to photos obtained during Cascadia field projects, photos contributed by other individuals (e.g., whale and dolphin watching operators) were added to the catalog to assess sighting history and association patterns.

Planning is underway for additional field operations in November 2015 and spring 2016.

RESULTS

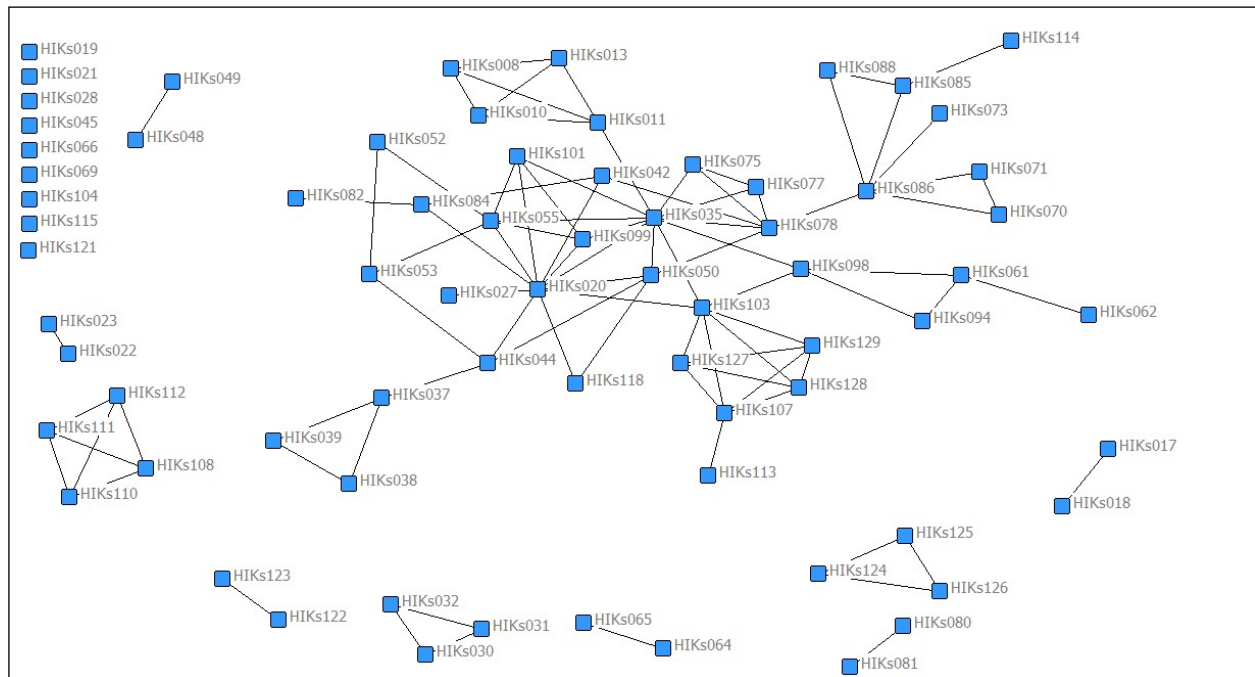


Figure 1. Social network of 72 dwarf sperm whales identified off the island of Hawai‘i from 2002 through June 2015. Each point represents an individual (with ID labels shown) and lines connect individuals seen in the same encounter. Forty-one of the 72 individuals (57%) are linked by association in the main cluster, and 21 of those (51.2%) were seen on more than one occasion, over spans of up to 9.9 years. All but six of the 31 other individuals (19.3%) were seen on only a single occasion, with the longest re-sighting interval of the six re-sighted individuals not in the main cluster of 1.27 years.

Long-term re-sightings of identified individuals provide evidence of a small population of dwarf sperm whales that is resident to the island of Hawai‘i. Five of the nine distinctive individuals photo-identified during our field efforts since October 2013 had been previously documented off the island. One adult female, HIKs020 in our photo-identification catalog, was first documented off the island in November 2004. Our sighting of this individual in October 2013 represents the ninth time HIKs020 had been documented (in seven different years). This individual was also photographically documented in October 2014, extending re-sightings to a 10-year span. Two other individuals were also documented over spans of five and six years. One is an adult female, while the other is a probable adult male (seen on seven occasions over a five-year span, never with calves in association), suggesting that both males and females show long-term fidelity to the island. Taking into account all photographically identified individuals (with some minimum distinctiveness and photo quality standards), 72 individual dwarf sperm whales have been documented off Hawai‘i Island since 2002. Of these, 41 have been linked together by association in a single social network (Figure 1), providing insights into the social organization of this species for the first time.

IMPACT/APPLICATIONS

Photo-identification data obtained is already providing hitherto unavailable information on the long-term site fidelity of dwarf sperm whales, including one adult female seen over a 10-year span off the island. While we have not yet been successful at deploying LIMPET satellite tags on either dwarf or pygmy sperm whales, these results are nonetheless important in understanding the potential for repeated exposure of dwarf sperm whales to Navy activities. These species inhabit Navy ranges, are potentially susceptible to impacts from naval activities, and yet because of the difficulty in detecting them in anything other than ideal sea conditions are underrepresented in sighting data. When we are eventually successful at tagging dwarf sperm whales, the information obtained will dramatically increase what is known about these very poorly understood species of odontocetes, and provide the first detailed movement data for these species. Information obtained will allow for an assessment of the likelihood of repeated exposure to anthropogenic activities as well as identify preferred habitats where overlap with anthropogenic activities is most likely to exist.

RELATED PROJECTS

Field work in October 2013 was undertaken in association with two other field efforts, to leverage additional field time to increase the likelihood of tagging success. One project is "Remote Release Device for Marine Mammal Electronic Tags" funded through a Science and Technology Transfer (STTR) program Phase II Option 1 contract, Office of Naval Research Contract N00014-11-C-0092 issued to Wildlife Computers with a subcontract to the Alaska SeaLife Center. The other project is "Hawaiian odontocete assessment: updating photo-identification catalogs for estimating abundance, assessing the nature and extent of fishery interactions with pantropical spotted dolphins, and examining false killer whale movements", funded by the NOAA Pacific Islands Fisheries Science Center (PIFSC) under Grant Number NA13OAR4540212. Field work in July 2014, November/December 2014 and April 2015 was also undertaken in association with the PIFSC grant. Field work undertaken in November/December 2014 was also undertaken in association with a project on "False killer whale movements in relation to longline fishing activity: assessment of interactions using satellite tag and fisheries data to develop best practices to reduce bycatch", funded by the NOAA Bycatch Reduction Engineering Program (BREP) under Grant Number NA14NMF4720319. Field work to be undertaken in November 2015 will be funded by a second year of NOAA BREP funding.

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